

L Number	Hits	Search Text	DB	Time stamp
1	21822	((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:29
2	80889	(electrode) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:30
3	68979	(barrier) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:31
4	163497	(protective) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:32
5	36759	(mask) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:33
6	1591	(first near mask) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:35
7	1417	(second! near mask) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:36
8	129276	cvd chemical adj vapor adj deposition	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:36
9	286375	sio2 "sio.sub.2" (silicon adj (oxide dioxide))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:37
10	31819	teos! bpsg! bsg! psg!	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:37
11	26517	si3n4 "si.sub.3 n.sub.4"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:37
12	220058	tin! tisin! tiwn! (titanium adj (nitride (silicon adj nitride) (tungsten adj nitride)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:38
13	204703	tan! tasin! ta! tantalum (tantalum adj (nitride (silicon adj nitride)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:38
14	7803	(etch-stop etch\$3 adj stop) near (layer film coating)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:49

15	657226	resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 14:52
18	530	HWANG-JENG-.in. HWANG-JENG-H-.in. HWANG-J-H-.in. MAK-STEVE-.in. MAK-STEVEN-.in. MAK-STEVEN-S-Y-.in. MAK-S-S-Y-.in. MAK-S-S-.in. LIN-TRUE-LON-.in. LIN-T-L-.in. YING-CHENTSAU-.in. SCHALLER-J-.in. SCHALLER-JOHN-W-.in. SCHALLER-JOHN-W-.in. SCHALLER-J-W-.in.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:29
19	22	(HWANG-JENG-.in. HWANG-JENG-H-.in. HWANG-J-H-.in. MAK-STEVE-.in. MAK-STEVEN-.in. MAK-STEVEN-S-Y-.in. MAK-S-S-Y-.in. MAK-S-S-.in. LIN-TRUE-LON-.in. LIN-T-L-.in. YING-CHENTSAU-.in. SCHALLER-J-.in. SCHALLER-JOHN-W-.in. SCHALLER-JOHN-W-.in. SCHALLER-J-W-.in.) and ((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 15:26
20	11	((("0865079") or ("0858103") or ("19728473") or ("0889519") or ("9931718") or ("9936956")).PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 16:49
24	5	((("0889519") or ("6037264") or ("6004882")).PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 16:50
27	2	ep-889519-\$.did.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 16:51
28	3	((("6090697") or ("6153490")).PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 16:52
29	24	((("6090697") or ("6153490") or ("6143476") or ("6482745") or ("6037264") or ("6004882") or ("5953576") or ("5702970") or ("5515984") or ("5515984") or ("6143476") or ("6001660") or ("5858824") or ("5686339") or ("5885891")).PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 16:53
30	11	((("6090697") or ("6153490") or ("6143476") or ("6482745") or ("6037264") or ("6004882") or ("5953576") or ("5702970") or ("5515984") or ("5515984") or ("6143476") or ("6001660") or ("5858824") or ("5686339") or ("5885891")).PN.) and (etch\$5 with ((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:13
32	10	HWANG-JENG-.in. HWANG-JENG-H-.in. HWANG-J-H-.in. MAK-STEVE-.in. MAK-STEVEN-.in. MAK-STEVEN-S-Y-.in. MAK-S-S-Y-.in. MAK-S-S-.in. LIN-TRUE-LON-.in. LIN-T-L-.in. YING-CHENTSAU-.in. SCHALLER-J-.in. SCHALLER-JOHN-W-.in. SCHALLER-JOHN-W-.in. SCHALLER-J-W-.in.	US-PGPUB	2003/02/26 17:30

33	1	((barrier) near (layer film coating)) and us-6482745-\$.did.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:32
34	1	((barrier) near (layer film coating)) and us-20020037647-\$.did.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:35
36	1	((barrier) near (layer film coating)) and us-6265318-\$.did.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:36
37	1	((barrier) near (layer film coating)) and us-6323132-\$.did.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:36
38	11	(((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) ((electrode) near (layer film coating))) same ((barrier) near (layer film coating)) same ((protective) near (layer film coating)) same ((mask) near (layer film coating)) same ((resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))) pattern\$6)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:47
39	45	(((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) ((electrode) near (layer film coating))) same ((barrier) near (layer film coating)) same ((mask) near (layer film coating)) same ((resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))) pattern\$6)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:51
40	34	(((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) ((electrode) near (layer film coating))) same ((barrier) near (layer film coating)) same ((mask) near (layer film coating)) same ((resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))) pattern\$6)) not (((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) ((electrode) near (layer film coating))) same ((barrier) near (layer film coating)) same ((protective) near (layer film coating)) same ((mask) near (layer film coating)) same ((resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))) pattern\$6))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:47
41	0	(((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) ((electrode) near (layer film coating))) same ((barrier) near (layer film coating)) same ((mask) near (layer film coating)) same ((resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))) pattern\$6) same ((etch-stop etch\$3 adj stop) near (layer film coating))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:51

42	1	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) ((electrode) near (layer film coating))) same ((barrier) near (layer film coating)) same ((first near mask) near (layer film coating)) same ((second! near mask) near (layer film coating)) same ((resist photoresist photo-resist photosensitive photo-sensitive (sensitive near (light energy radiation photo))) pattern\$6)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:52
44	1541	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:08
45	297	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5) same ((barrier) near (layer film coating)) (tin! tisin! tiwn! (titanium adj (nitride (silicon adj nitride) (tungsten adj nitride)))) (tan! tasin! ta! tantalum (tantalum adj (nitride (silicon adj nitride))))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:54
47	5	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5 with (heat\$3 temperture)) same ((barrier) near (layer film coating))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:07
46	102	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5 with (heat\$3 temperture)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 17:57
48	18	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5 with (heat\$3 temperture)) and ((barrier) near (layer film coating))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:07
49	5705	((barrier) near (layer film coating)) with etch\$5	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:08
50	185	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5) and ((barrier) near (layer film coating)) with etch\$5)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:08
51	93	((((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating)) with etch\$5) same ((barrier) near (layer film coating)) with etch\$5)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:08
31	43	etch\$5 with ((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating))) same (hbr bcl3 "bcl.sub.3" hydrogen adj bromide hydrobromic adj acid boron adj trichloride)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 19:48
52	2	("6143476").PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 18:23
53	2255	(noble adj gas) with (n n2 "n.sub.2" nitrogen)	USPAT	2003/02/26 18:59
54	1114	(noble adj gas) near (n n2 "n.sub.2" nitrogen)	USPAT	2003/02/26 18:59

56	6	((("5686339") or ("5840200") or ("5854104"))).PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:03
57	3	((("5686339") or ("5840200") or ("5854104"))).PN.) and (heat\$3 temperature)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:05
58	1214	((barrier) near (layer film coating)) near etch\$3	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:06
59	77	((barrier) near (layer film coating)) near etch\$3 with (known conventional\$3 typical\$3 optional\$3 prefer\$5)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:14
62	123	((etch-stop etch\$3 adj stop) near (layer film coating)) with ((barrier) near (layer film coating)) with substrate	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:22
63	70	(hard adj mask hard-mask) with ((barrier) near (layer film coating)) with substrate	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:29
64	317	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) near3 (over on top) near3 substrate	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:26
65	17	((hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) near3 (over on top) near3 substrate) same ((barrier) near (layer film coating))	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:26
67	16	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with ((barrier) near (layer film coating)) with substrate with between	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:36
66	190	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with ((barrier) near (layer film coating)) with substrate	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM TDB	2003/02/26 19:38
68	984	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) near3 substrate	USPAT	2003/02/26 19:39
69	19	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) near substrate near ("on" top over)	USPAT	2003/02/26 19:41
70	9	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with directly with substrate with ("on" top over)	USPAT	2003/02/26 19:43
71	173	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with protect\$5 with substrate	USPAT	2003/02/26 19:44
72	173	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with protect\$5 with substrate	USPAT	2003/02/26 19:46
73	2	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with protect\$5 with substrate with directly	USPAT	2003/02/26 19:46

74	6	(hard adj mask hard-mask ((etch-stop etch\$3 adj stop) near (layer film coating))) with protect\$5 with substrate with (known conventional\$3 typical\$3)	USPAT	2003/02/26 19:47
75	19	(etch\$5 with ((noble adj metal) pt platinum ir iridium pd palladium ru ruthenium) near (layer film coating))) same (hbr bcl3 "bcl.sub.3" hydrogen adj bromide hydrobromic adj acid boron adj trichloride) same (noble adj gas he helium ne neon ar argon kr krypton xe xenon ra radon)	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2003/02/26 19:50

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TITLE: Etching a noble metal layer that is disposed on a substrate by employing a plasma of an etchant gas from a halogen containing gas, noble gas, nitrogen containing gas, and/or oxygen

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PATENT-ASSIGNEE: APPLIED MATERIALS INC[MATEN]

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ABSTRACTED-PUB-NO: WO 200049651A

BASIC-ABSTRACT: NOVELTY - A noble metal layer that is disposed on a substrate is etched including employing a plasma of an etchant gas from a halogen containing gas, a noble gas, nitrogen containing gas, and/or oxygen.

DETAILED DESCRIPTION - Etching a noble metal layer (15) that is disposed on a substrate (12) comprises providing a substrate supporting a barrier layer (14), a noble metal layer, a protective layer on the noble metal layer, a mask layer (18) on the protective layer, and a patterned resist layer (20a-20d) on the mask layer. A portion of the mask layer is then etched using plasma of a mask etchant gas to break through and remove the mask layer from the protective layer exposing part of the protective layer to produce the substrate. The patterned resist layer is then removed from the residual mask layer (18a-18d) to produce the substrate supporting the rest of the layers. The expose part of the protective layer is then etched to expose part of the noble metal layer and to produce the substrate supporting the barrier layer, the noble metal layer on the barrier layer, a residual protective layer on the noble metal layer, and the residual mask layer on the residual protective layer. The substrate is then heated at 150 deg. C. The exposed part of the noble metal layer is then etched including employing a plasma of an etchant gas from a halogen containing gas, a noble gas, nitrogen containing gas, and/or oxygen. The residual mask layer is then removed from the residual protective layer followed by etching a

portion of the barrier layer then etched including employing a plasma of a barrier etchant gas to produce a substrate supporting the remaining layers.

Etching a noble metal layer to produce semiconductor integrated circuits containing noble metal electrodes includes employing a plasma of an etchant gas from a halogen containing gas, a noble gas, nitrogen containing gas, and/or oxygen

USE - For etching noble metal layer that is disposed on a substrate to produce semiconductor integrated circuits containing noble metal electrodes.

ADVANTAGE - The method produces high-density integrated circuit semiconductor electrodes with a high degree of noble metal profile anisotropy.

DESCRIPTION OF DRAWING(S) - The figure shows a side elevational view of a semiconductor wafer.

Substrate 12

Barrier layer 14

Noble metal layer 15

Mask layer 18

Residual mask layer 18a-18d

Patterned resist layers 20a-20d

CHOSEN-DRAWING: Dwg.1/48

TITLE-TERMS:

ETCH NOBLE METAL LAYER DISPOSABLE SUBSTRATE EMPLOY PLASMA
ETCH GAS HALOGEN
CONTAIN GAS NOBLE GAS NITROGEN CONTAIN GAS OXYGEN

DERWENT-CLASS: L03 U11 U12 U13 U14

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: IMPROVED MASKING METHODS AND ETCHING SEQUENCES FOR PATTERNING ELECTRODES OF HIGH DENSITY RAM CAPACITORS

(57) Abstract: A method of etching a noble metal electrode layer disposed on a substrate to produce a semiconductor device including a plurality of electrodes separated by a distance equal to or less than about 0.35 μm and having a noble metal profile equal to or greater than about 80°. The method comprises heating the substrate to a temperature greater than about 150°C, and etching the noble metal electrode layer by employing a high density inductively coupled plasma of an etchant gas comprising a gas selected from the group consisting of nitrogen, oxygen, a halogen (e.g., chlorine), argon, and a gas selected from the group consisting of BCl_3 , HRBr , and SiCl_4 mixtures thereof. A semiconductor device having a substrate and a plurality of noble metal electrodes supported by the substrate. The noble metal electrodes have a dimension (e.g., a width) which include a value equal to or less than about 0.3 μm and a platinum profile equal to or greater than about 85°. Masking methods and etching sequences for patterning high density RAM capacitors are also provided. The substrate may be heated by a pedestal in a reactor chamber having a dielectric window including a deposit-receiving surface having a surface finish comprising a peak-to-valley roughness height with an average height value of greater than about 1,000Å.

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WHAT IS CLAIMED IS:

1. A method of etching a noble metal layer disposed on a substrate comprising the steps of:
 - a) providing a substrate supporting a barrier layer, a noble
5 metal layer on said barrier layer, a protective layer on said noble metal layer, a mask layer on said protective layer, and a patterned resist layer on said mask layer;
 - b) etching a portion of said mask layer including employing a plasma of a mask etchant gas to break through and to remove said portion of said mask layer from said protective layer to expose part of said protective layer and to produce said
10 substrate supporting said barrier layer, said noble metal layer on said barrier layer, said protective layer on said noble metal layer, a residual mask layer on said protective layer, and said patterned resist layer on said residual mask layer;
 - c) removing said patterned resist layer from said residual mask layer of step (b) to produce said substrate supporting said barrier layer, said noble metal
15 layer on said barrier layer, said protective layer on said noble metal layer, and said residual mask layer on said protective layer;
 - d) etching said exposed part of said protective layer to expose part of said noble metal layer and to produce said substrate supporting said barrier layer, and said noble metal layer on said barrier layer, a residual protective layer on said noble
20 metal layer, and said residual mask layer on said residual protective layer;
 - e) heating said substrate of step (d) to a temperature greater than about 150°C;
 - f) etching said exposed part of said noble metal layer of step (d) including employing a plasma of an etchant gas selected from the group consisting of
25 a halogen containing gas, a noble gas, nitrogen, oxygen, and mixtures thereof, to produce said substrate supporting said barrier layer, an etched noble metal layer on said barrier layer, said residual protective layer on said etched noble metal layer, and said residual mask layer on said residual protective layer;
 - g) removing said residual mask layer from said residual
30 protective layer to produce said substrate supporting said barrier layer, said etched noble

metal layer on said barrier layer, and said residual protective layer on said etched noble metal layer; and

- h) etching a portion of said barrier layer including employing a plasma of a barrier etchant gas to expose part of the substrate to produce said substrate supporting a residual barrier layer, said etched noble metal layer on said residual barrier layer, and said residual protective layer on said etched noble metal layer.

2. The method of Claim 1 wherein said step (f) etching of said noble metal layer of step (d) additionally produces a remaining noble metal layer on said barrier layer, said step (g) removing of said residual mask layer additionally produces said remaining noble metal layer on said barrier layer, and said method additionally comprises etching said remaining noble metal layer on said barrier layer prior to said step (h) etching.

3. The method of Claim 1 additionally comprising removing said residual protective layer from said etched noble metal layer.

4. The method of Claim 1 wherein said step (f) etching of said noble metal layer of step (d) additionally produces a remaining noble metal layer on said barrier layer, said step (g) removing of said residual mask layer additionally produces said remaining noble metal layer on said barrier layer, and said method additionally comprises etching said residual protective layer and said remaining noble metal layer on said barrier layer prior to said step (h) etching.

5. The method of Claim 3 wherein said removing of said residual protective layer from said etched noble metal is simultaneous with said etching step (h).

6. The method of Claim 1 wherein said mask layer comprises CVD SiO₂.

7. The method of Claim 2 wherein said mask layer and said substrate comprises CVD SiO₂.

8. The method of Claim 4 wherein said mask layer comprises CVD SiO₂.

9. The method of Claim 1 wherein said mask layer comprises a compound selected from the group consisting of TEOS, CVD SiO₂, Si₃N₄, BSG, PSG, BPSG, a low dielectric constant material with a dielectric constant less than about 3.0, and mixtures thereof.

10. The method of Claim 1 wherein said barrier layer comprises a compound selected from the group consisting of TiN, TiSiN, Ti, WN, TaN, TaSiN, Ta, and mixtures thereof.

11. The method of Claim 1 wherein said protective layer comprises a compound selected from the group consisting of TiN, TiSiN, Ti, WN, TaN, TaSiN, Ta, and mixtures thereof.

12. The method of Claim 1 wherein said mask layer has a thickness ranging from about 6000Å to about 9,000Å.

13. A method of etching a noble metal layer disposed on a substrate comprising the steps of:

- a) providing a substrate supporting a barrier layer, a noble metal layer on said barrier layer, a mask layer on said noble metal layer, and a patterned resist layer on said mask layer;
- b) etching a portion of said mask layer including employing a plasma of a mask etchant gas to break through and to remove said portion of said mask layer from said noble metal layer to expose part of said noble metal layer and to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, a residual mask layer on said noble metal layer, and said patterned resist layer on said residual mask layer;
- c) removing said patterned resist layer from said residual mask layer of step (b) to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, and said residual mask layer on said noble metal layer;

- d) heating said substrate of step (c) to a temperature greater than about 150°C;
- e) etching said exposed part of said noble metal layer of step (c) including employing a plasma of an etchant gas selected from the group consisting of a halogen containing gas, a noble gas, nitrogen, oxygen, and mixtures thereof, to produce said substrate supporting said barrier layer, an etched noble metal layer on said barrier layer, and said residual mask layer on said etched noble metal layer;
- f) removing said residual mask layer from said etched noble metal layer to produce said substrate supporting said barrier layer and said etched noble metal layer on said barrier layer; and
- g) etching a portion of said barrier layer including employing a plasma of a barrier etchant gas to expose part of the substrate to produce said substrate supporting a residual barrier layer and said etched noble metal layer on said residual barrier layer.
14. A method of etching a noble metal layer disposed on a substrate comprising the steps of:
- a) providing a substrate supporting a barrier layer, a noble metal layer on said barrier layer, a protective layer on said noble metal layer, a mask layer on said protective layer, and a patterned resist layer on said mask layer;
- b) etching a portion of said mask layer including employing a plasma of a mask etchant gas to break through and to remove said portion of said mask layer from said protective layer to expose part of said protective layer and to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, said protective layer on said noble metal layer, a residual mask layer on said protective layer, and said patterned resist layer on said residual mask layer;
- c) removing said patterned resist layer from said residual mask layer of step (b) to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, said protective layer on said noble metal layer, and said residual mask layer on said protective layer;

- d) etching said exposed part of said protective layer to expose part of said noble metal layer and to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, a residual protective layer on said noble metal layer, said residual mask layer on said residual protective layer, and said patterned resist layer on said residual mask layer;
- e) heating said substrate of step (d) to a temperature greater than about 150°C;
- f) etching said exposed part of said noble metal layer of step (d) including employing a plasma of an etchant gas selected from the group consisting of a halogen containing gas, a noble gas, nitrogen, oxygen, and mixtures thereof, to produce said substrate supporting said barrier layer, an etched noble metal layer on said barrier layer, said residual protective layer on said etched noble metal layer, and said residual mask layer on said residual protective layer;
- g) etching a portion of said barrier layer including employing a plasma of a barrier etchant gas to expose part of the substrate to produce said substrate supporting a residual barrier layer, said etched noble metal layer on said residual barrier layer, said residual protective layer on said etched noble metal layer, and said residual mask layer on said residual protective layer; and
- h) removing said residual mask layer from said residual protective layer to produce said substrate supporting said residual barrier layer, said etched noble metal layer on said residual barrier layer, and said residual protective layer on said etched noble metal layer.

15. The method of Claim 14 wherein said barrier layer comprises a compound selected from the group consisting of TiN, TiSiN, Ti, WN, TaN, TaSiN, Ta, and mixtures thereof.

16. The method of Claim 14 wherein said protective layer comprises a compound selected from the group consisting of TiN, TiSiN, Ti, WN, TaN, TaSiN, Ta, and mixtures thereof.

17. The method of Claim 14 wherein said mask layer has a thickness ranging from about 6000Å to a about 9,000Å.

18. The method of Claim 14 wherein said mask layer comprises a
5 compound selected from the group consisting of Si₃N₄, BSG, PSG, BPSG, a low dielectric constant material with a dielectric constant of less than about 3.0, and mixtures thereof.

19. A method of etching a noble metal layer disposed on a substrate
10 comprising the steps of:

- a) providing a substrate supporting an etch-stop layer, a barrier layer on said etch-stop layer, a noble metal layer on said barrier layer, a mask layer on said noble metal layer, and a patterned resist layer on said mask layer;
- b) etching a portion of said mask layer including employing a
15 plasma of a mask etchant gas to break through and to remove said portion of said mask layer from said noble metal layer to expose part of said noble metal layer and to produce said substrate supporting said etch-stop layer, said barrier layer on said etch-stop layer, said noble metal layer on said barrier layer, a residual mask layer on said noble metal layer, and said patterned resist layer on said residual mask layer;
- c) removing said patterned resist layer from said residual mask
20 layer of step (b) to produce said substrate supporting said etch-stop layer, said barrier layer on said etch-stop layer, said noble metal layer on said barrier layer, and said residual mask layer on said noble metal layer;
- d) heating said substrate of step (c) to a temperature greater
25 than about 150°C;
- e) etching said exposed part of said noble metal layer including employing a plasma of an etchant gas selected from the group consisting of a halogen containing gas, a noble gas, nitrogen, oxygen, and mixtures thereof, to expose
30 part of the barrier layer and to produce said substrate supporting said etch-stop layer, said barrier layer on said etch-stop layer, an etched noble metal layer on said barrier layer, and said residual mask layer on said etched noble metal layer;

- f) etching said exposed part of said barrier layer to expose part of said etch-stop layer and to produce said substrate supporting said etch-stop layer, a residual barrier layer on said etch-stop layer, said etched noble metal layer on said residual barrier layer, and said residual mask layer on said etched noble metal layer; and
- 5 g) removing said residual mask layer from said etched noble metal layer to produce said substrate supporting said etch-stop layer, said residual barrier layer on said etch-stop layer, and said etched noble metal layer on said residual barrier layer.

10 20. The method of Claim 19 additionally comprising etching said etch-stop layer.

21. The method of Claim 19 wherein said mask layer comprises a compound selected from the group consisting of CVD SiO₂, TEOS, BSG, PSG, BPSG, a
15 low dielectric constant material with a dielectric constant of less than about 3.0.

22. A method of etching a noble metal layer disposed on a substrate comprising the steps of:

- a) providing a substrate supporting a barrier layer, a noble
20 metal layer on said barrier layer, a first mask layer on said noble metal layer, a second mask layer on said first mask layer, and a patterned resist layer on said second mask layer;
- b) etching a portion of said second mask layer including
employing a plasma of a mask etchant gas to break through and to remove said portion of
25 said second mask layer from said first mask layer to expose part of said first mask layer and to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, said first mask layer on said noble metal layer, a residual second mask layer on said first mask layer, and said patterned resist layer on said residual second mask layer;
- 30 c) etching said exposed part of said first mask layer to expose part of said noble metal layer and to produce said substrate supporting said barrier layer,

said noble metal layer on said barrier layer, a residual first mask layer on said noble metal layer, said residual second mask layer on said residual first mask layer, and said patterned resist layer on said residual second mask layer;

5 d) removing said patterned resist layer from said residual second mask layer of step (c) to produce said substrate supporting said barrier layer, said noble metal layer on said barrier layer, and said residual first mask layer on said noble metal layer, and said residual second mask layer on said first residual mask layer;

e) heating said substrate of step (d) to a temperature greater than about 150°C;

10 f) etching said exposed part of said noble metal layer and said residual second mask layer of step (d) including employing a plasma of an etchant gas selected from the group consisting of a halogen containing gas, a noble gas, nitrogen, oxygen, and mixtures thereof, to produce said substrate supporting said barrier layer, an etched noble metal layer on said barrier layer, and said residual first mask layer on said
15 etched noble metal layer;

g) etching said barrier layer to remove a portion of the barrier layer from said substrate to produce said substrate supporting a residual barrier layer, said etched noble metal layer on said residual barrier layer, and said residual first mask layer on said etched noble metal; and

20 h) removing said residual first mask layer from said etched noble metal layer to produce said substrate supporting said residual barrier layer, and said etched noble metal layer on said residual barrier layer.

23. The method of Claim 22 wherein said patterned resist layer is
25 removed from said residual second mask layer during said etching step (c).

24. The method of Claim 22 wherein said first mask layer comprises a compound selected from the group consisting of Si₃N₄, BSG, PSG, BPSG, an organic polymer, a low dielectric constant material having a dielectric constant of less than about
30 3.0, and mixtures thereof.

25. The method of Claim 22 wherein said second mask layer comprises a compound selected from the group consisting of CVD SiO₂, TEOS, Si₃N₄, BSG, PSG, BPSG, SiC, and mixtures thereof.

5 26. The method of Claim 22 wherein said first mask layer has a thickness ranging from about 3000Å to about 8000Å.

27. The method of Claim 22 wherein said second mask layer has a thickness ranging from about 500Å to about 4000Å.

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28. The method of Claim 22 wherein said etching step (g) additionally comprises etching into said substrate.

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 00/04240

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L21/3213

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

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A	same applicant the whole document	7, 12, 17, 22-24, 28
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X	DE 197 28 473 A (SIEMENS AG) 7 January 1999 (1999-01-07)	14-16
A	column 4 -column 5; figures 1-6	19, 22, 24
X	EP 0 889 519 A (TEXAS INSTRUMENTS INC) 7 January 1999 (1999-01-07)	22, 28
A	page 6, line 28 -page 7, line 25; figures 8F-8J	19
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

International Application No.

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★ priority
to 09/006,092

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